SOIL MICROBES AND DROUGHT: CROPPING SYSTEMS

Microbial function and adaptation in response to climate change driven drought and the resulting effects on plant production and nutrient cycling

Microbes are important for many soil processes that contribute to the production of food and fibre on which humans rely. Under climate change, there is likely to be an increase in the intensity and frequency of drought in New Zealand but little remains known about how drought affects soil microbes. Therefore, we conducted a literature review to assess what we do and do not know about the effects of climate change-driven drought on soil microbial function and adaptation and how this might affect plant production and nutrient cycling.

We assessed a broad range of literature that considered how microbes respond to drought and how that affects carbon, nitrogen and phosphorus cycling in cropping soils. We reviewed the interaction between microbes and soil water repellency and how plant production and pathogens might behave under drought. Further, we evaluated how advanced genetic techniques could contribute to understanding the effects of drought on microbial community composition and the ability of microbes to cycle organic matter. Finally, we also investigated possible mitigation strategies to lessen the effects of drought on soil microbes.

Drought effects on soil microbes

During drought:

- Microbial function decreases and reduces C, N, and P cycling
- Microbial community structure is altered
- Soil water repellency may worsen the effects drought
- Pathogen disease expression will vary, but will likely increase under drought conditions
- Nutrient cycling and plant production will decrease

The persistence of drought effects on microbes will be affected by the duration, intensity, and timing of drought and the subsequent rewetting phase.

The Team:
Suzanne Lambie (lead)[1] Kate Orwin[1] Karin Müller[2] Gavin Lear[3] Steven A Wakelin[4] Simeon Smaill[4]
[1] Landcare Research [2] Plant & Food Research [3] The university of Auckland [4] AgResearch [5] SCION

What don't we know about the effect of drought on microbes?

We found a lack of information applicable to New Zealand and identified a large number of areas that need more information to adequately understand and prepare for future climate change-driven drought events. For example, we don't know how and to what extent soil water repellency will increase the negative effects of drought. There may also be a trigger level of soil moisture above which the negative effects of drying and re-wetting are avoidable. However, further work is needed to determine these trigger values, and they are likely to be soil and land use specific. The effects of pathogen infection and disease expression in crop plants will likely be increased under drought conditions. However, further information on the effects of drought on common New Zealand crops is needed, as well as research into the interaction between drought and elevated temperatures on plant pathogens.

What can the cropping industry do to prepare for climate change driven drought?

The effect of drought on crops is likely to be dependent on the time scale for which the crop is harvested, i.e. for wheat or brassica crops the effect of drought could be catastrophic but for perennial crops (such as oranges or apples) the effect may not be as disastrous when averaged over several years rather than evaluating a single harvest. While the most obvious solution to drought is irrigation, this is not always a viable option. With increasing pressure on our water resources (e.g. local groundwater depletion and reduced groundwater recharge rates) irrigation may not be a long term solution in the face of an increasing number and length of droughts.

Increasing the soil organic matter contents of soil will increase the amount of water a soil can hold as well as feed microbes and plants to maintain their growth in drought periods. Further, preventing or remediating water-repellent soil conditions will also decrease the effects of drought on soil microbes, although these strategies will be soil- and site-specific.

There are strategies that are more directed at helping plants survive drought conditions, including spraying plants with chemicals to increase their drought tolerance. The development of more drought resistant plants is also an option being explored by many researchers around the globe.

The introduction of biofertilisers (fertilisers that include specific microorganisms that can enhance drought tolerance of plants, e.g. mycorrhizal fungi) is also being researched internationally but results remain inconclusive in New Zealand.

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